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(54) INSECT EXTERMINATING APPARATUS

(71) We, THORN DOMESTIC APPLIANCES (ELECTRICAL) LIMITED, a British Company of Thorn House, Upper St. Martins Lane, London, WC2H 9ED, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an insect exterminating apparatus.

Insect exterminating apparatuses are known in which a bait or lure for insects is placed within a hollow grid formed of electrodes across which a high voltage is applied. Insects attracted by the bait or lure attempt to pass through the grid and in bridging two electrodes which are at different potentials are subjected to the high voltage which usually results in their being killed, stunned or severely damaged.

According to the present invention there is provided an insect exterminating apparatus, such apparatus comprising: a hollow grid assembly which can contain an insect lure and comprising at least one first electrode and at least one second electrode; and means for applying a high voltage across the first and second electrodes, said means comprising a battery operable DC to DC inverter and a capacitor which is connected across the first and second electrodes and is arranged to store electrical energy supplied by said inverter and which, in use, is dissipated via an insect bridging the first and second electrodes.

When an insect bridges the electrodes quite a high current is drawn and the provision of the capacitor connected across the electrodes obviates the need for the part of the high voltage supplying means which charges the capacitor to provide this current; the energy stored across the capacitor can be built up relatively slowly and can then be rapidly dissipated via an insect bridging the electrodes.

Preferably the capacitor is charged by a rectifying circuit connected to the secondary winding of a transformer arranged in a voltage step-up configuration. In view of the provision of the capacitor, both the transformer and the rectifying circuit can have a very much lower current rating than would be necessary if the capacitor were absent. While the primary of the transformer could be connected across an alternating current main supply, it is preferred that the primary forms part of a power oscillator circuit so that the high voltage across the electrodes can be derived from one or more cells thus rendering the apparatus considerably more portable than if it were mains operated. The overall operation of the oscillator, transformer and rectifying circuit is as a DC to DC inverter. In order to obtain an adequately high voltage across the electrodes, which is preferably from 2 to 3 kilovolts, without excessive current drain on the cells, and excessive transformer size, the rectifying circuit is preferably a Cockcroft and Walton voltage multiplying circuit. A suitable circuit for the oscillator uses a programmable unijunction transistor and associated timing network, which drives a Darlington pair in series with the transformer primary.

Preferably the DC to DC inverter, capacitor and cells are located within a housing on which the grid assembly is mounted by means of plug in connectors. The grid assembly is suitably covered with a wire mesh guard from which it is electrically insulated, this guard having apertures allowing insects to gain access to the grid assembly and being dimensioned and arranged so that it is very difficult if not impossible for a person's finger to touch the grid assembly through the wire mesh. A tray is suitably provided between

the grid assembly and the housing in order to collect the bodies and remains of insects electrocuted by the grid assembly, this tray being removable from the housing to enable it to be cleaned and providing a receptacle located within the grid assembly and into which a scent attractant such as decaying animal or vegetable matter can be placed to attract insects. Preferably, the grid assembly is secured to the wire mesh guard so that as the wire mesh guard is removed from the housing the grid assembly comes away with the guard and is thereby unplugged from the capacitor and DC to DC inverter output so that it becomes electrically dead. Since the capacitor could store a dangerous amount of energy, preferably switches are arranged on the housing to detect removal of the wire mesh guard and/or disassembly of the housing, these switches being operable on detection of such removal to short circuit the capacitor thereby discharging it and to interrupt the supply from the cells to the oscillator to prevent the capacitor from being recharged.

Since scent attractants tend to be specific to particular types of insects, it is sometimes desirable to have an attractant which will be effective with a wider range of insects. An ultra-violet lamp will provide a fairly general insect attractant and may be placed within the grid assembly. Plasma discharge tubes provide suitable ultra-violet light sources and such a discharge tube may be placed in the secondary circuit of the transformer and operated by current flowing as a result of losses within the secondary circuit.

The invention also provides an insect extermnating apparatus comprising a hollow grid assembly which can contain an insect lure and comprising a first electrode and a second electrode, the electrodes being wound around a plurality of spaced apart supports such that along the length of each support portions of the first and second electrodes are disposed in alternation, and means for applying a high voltage across the first and second electrodes said means comprising a battery operable DC to DC inverter and a capacitor which is connected across the first and second electrodes and is arranged to store electrical energy supplied by said inverter and which, in use, is dissipated via an insect bridging the first and second electrodes.

The invention will be further described with reference to the accompanying drawings, in which:—

Figure 1 is a cross-section view of a preferred embodiment of the present invention; and

Figure 2 is a circuit diagram of the inverter circuit used in the embodiment of Figure 1.

As shown in Figure 1 the preferred embodiment of insect exterminator 1 comprises a housing or base portion 2 of plastics material which contains an inverter 11 which supplies a high DC voltage across a grid assembly 3 mounted on top of the housing 2. A removable wire mesh guard 5, which is interconnected with base portion 2 by a snap-fitting band (not referenced), prevents people from touching the electrodes of the grid assembly. Any insect which bridges the electrodes of the grid assembly receives a power shock from the inverter output capacitor. Electrocuted insects such as houseflies or the remains of such insects are collected in a removable plastics tray 7 to which access can be gained by removing the wire mesh 5 and grid assembly 3, the tray 7 being removable from the base 2 to enable it to be washed. Sometimes an insect is only stunned by the electric shock it receives and this eventually can be provided for by putting water containing a small amount of detergent in the tray 7 so that such stunned insects fall into the tray and drown.

The wire mesh 5 is insulated from the grid assembly 3 by a plastics member 25 and pillar assembly 21 and 23 and has apertures therethrough which are, of course, sufficiently large to admit those insects which it is desired to kill but not so large as to enable a person to touch the grid assembly 3. Disposed within the grid assembly 3 are one or more lures for insects. Thus it will be seen that within the grid assembly 3 is a plasma discharge lamp 17, this plasma discharge lamp in use emitting ultra-violet light, to which a wide variety of insects are known to be attracted. Also the central portion of the tray 7 is in the form of a pedastal 13 which defines a receptacle 15 into which a scent attractant may be placed. This may either be a chemical composition or material such as decaying animal or vegetable matter. It has been found that scent attractants tend to be specific to particular types of insects.

The grid assembly 3 comprises first and second helical electrodes 19 and 20 which are arranged in a similar manner as are starts of a screw-thread. The two helices are coaxial and of equal diameter so that both electrodes conform to the same vertically extending cylindrical surface with the turns of one electrode alternating with the turns of the other along the length of this surface. This arrangement means that each turn of each electrode is substantially horizontal so that the gaps through which the insects attempt to gain access to the lure within the grid assembly 3 are also generally horizontal. This is advantageous as it has been found that flying insects are

more favourably pre-disposed towards flying between horizontal electrodes than they are to flying between vertical electrodes. The use of helical electrodes makes the grid assembly very easy to construct and, by making the input electrical connections to the electrodes at points which are angularly spaced apart about the axis of the helices, for example 120° apart, tracking between the electrodes is minimal. The electrodes 19 and 20 are secured to upright pillars 21 and 23, these pillars 21 and 23 being made of an electrically insulating material e.g. plastics and being fixed to the member 25 of a similar material. In order to connect the electrodes 19 and 20 with the output of the inverter 11, they are provided with respective male connecting pins 27 and 28 which project down through apertures in the tray 7 and the top wall of the base 2 to engage in associated female connectors 29 and 30. When the wiremesh guard 5 is removed from the base 2, the grid assembly 3 is thus able to come away with the wire mesh 5 and the electrodes 19 and 20 thereof are thereby unplugged from the inverter output so that the grid assembly 3 becomes electrically "dead" as soon as it and the guard 5 are removed from base 2. The provision of the female connectors 29 and 30 help to ensure that there are no exposed portions of the inverter output circuit which are readily accessible even with the wire mesh guard 5 removed.

Similar connectors are also provided for the plasma discharge lamp 17 which is also secured to the member 25 so that the lamp 17 also comes away from base 2 when the guard 5 is removed.

Since the output capacitor of the inverter 11 stores a potentially dangerous amount of energy, micro-switches or similarly operating devices are provided both to short the inverter output capacitor and to disconnect the battery supply to the inverter, as soon as the wire mesh guard 5 is removed from the base 2.

Regarding the plastics materials used, it should be noted that some insects appear to have aversion to certain types of plastics material e.g. perspex, which counteracts the effect of the lure. Polycarbonate appears to be an appropriate material for use with domestic houseflies and the like.

Figure 2 shows a circuit diagram of the apparatus of Figure 1 from which it will be seen that a DC to DC inverter is used to charge an output capacitor C6. The primary winding of a transformer T1 is connected in an oscillator circuit which comprises transistors TR1 and TR2 and is connected across the batteries contained in the compartment 9 of the base 2. A suitable supply voltage from the batteries is, for example, between 6 and 9 volts. Connected to the secondary of transformer T1 is a Cockcroft and Walton voltage multiplying and rectifying circuit which comprises diodes D1-4 and capacitors C2-5 which rectify and voltage multiply the output from the secondary of transformer T1 so that a high DC voltage typically between 2KV and 3KV is developed across a capacitor C6 at the output of the circuit. It will be seen that two switches S1 and S2 are provided, S1 controlling the current supply from the batteries to the low voltage oscillator and S2 being arranged to short the output capacitor C6. These switches, mentioned in connection with Figure 1 are positioned within the base 2 to be operated by removal of the guard 5 and electrodes 19 and 20 from base 2 such that S1 can only be closed and S2 can only be opened when the wire mesh guard 5 is correctly placed on the base 2. Removal of the wire mesh guard 5 and the grid assembly comprising electrodes 19 and 20 is arranged to cause switch S1 to open so interrupting the oscillator and thereby preventing capacitor C6 from being charged and S2 to close thereby ensuring that the voltage across the female connectors 29 and 30 mounted on base 2 is zero.

It will be appreciated that by providing a capacitor such as capacitor C6 connected across the electrodes 19 and 20, such a capacitor can store energy produced by the DC to DC inverter and can rapidly discharge this energy through an insect connected across electrodes 19 and 20. The provision of the capacitor greatly increases the effectiveness of the apparatus since it effectively presents a very low impedance from the point of view of the current which flows through an insect bridging the electrodes 19 and 20. The capacitor C6 can be charged up relatively slowly by the DC to DC inverter so that the DC to DC inverter and the batteries do not have to be able to supply the full short circuit current which flows at the output when an insect bridges the electrodes 19 and 20.

Considering the low voltage oscillator which includes the primary of transformer T1, it will be seen that this oscillator also comprises a programable unijunction transistor TR1 which drives a transistor TR2, the collector of which is connected in series with the transformer T1 primary.

In operation, capacitor C1 charges *via* R3 until the voltage at their common junction exceeds the triggering voltage of transistor TR1 defined by the voltage at the junction of fixed resistors R1 and R2. When the triggering voltage is exceeded a current pulse is applied to the input of transistor TR2 as capacitor C1 discharges.

When TR2 turns off, energy stored in

the transformer core generates a back-EMF voltage on both primary and secondary transformer windings, the secondary being used to drive the Cockroft and Walton voltage multiplying circuit described earlier. The actual voltage at the primary winding is directly proportional to the output voltage of the Cockroft and Walton circuit and this voltage across the primary is used to control the frequency of operation of the oscillator *via* a zener diode D5. When diode D5 begins to conduct, capacitor C8 charges to a higher voltage than that determined by the voltage divider formed of resistors R1 and R2 and thus increases the bias applied to transistor TR1. This in turn increases the time taken for C1 to reach the triggering voltage of TR1 and hence the frequency of operation of the oscillator reduces. This process continues until the voltage on capacitor C8 is sufficiently high for the pulses applied to TR2 to be just sufficiently frequent to replace the losses and leakages in the transformer secondary circuit, principally losses in the Cockroft and Walton voltage multiplier. Thus the voltage output is stabilised depending on the break over voltage of zener diode D5. Should capacitor C6 be discharged, D5 will fail to maintain capacitor C8 at a high voltage and hence the oscillator frequency will increase so as rapidly to recharge capacitor C6. Thus it will be appreciated that this manner of operation of the oscillator circuit serves to prolong the battery life since between occasions when capacitor C6 is being recharged, the current drawn is just sufficient to make up for losses and leakages.

As mentioned earlier the secondary of transformer T1 is connected to a Cockroft and Walton voltage multiplying circuit comprising diodes D1-4 and capacitors C2-5, the high DC output voltage of which is applied across a capacitor C6. Although the capacitor C6 may be connected directly with the electrodes of the grid assembly via the female connectors 29 and 30, if desired it is possible to include in one or both of the leads from capacitor C6 to the grid electrodes a spark gap device (not shown) which is arranged to change its electrical resistance from a very high value to a relatively lower one when an insect bridges the electrodes 19 and 20. Such a spark gap device SG1 may comprise a pair of spaced apart electrodes in a sealed tube containing a suitable atmosphere. The purpose of spark gap device is that all the while no insect bridges the electrodes 19 and 20, only a very small current is being drawn from the capacitor C6 and this causes the spark gap device to be in its highly resistive condition and thereby drop most of the output voltage from capacitor C6. This means that until an insect does bridge the electrodes 19 and 20 there is a relatively smaller voltage across the electrodes 19 and 20 which helps prevent the accumulation of dust and other material on the electrodes. When an insect bridges electrodes 19 and 20 more current is drawn and the spark gap device changes from its high resistance to its low resistance state to optimise the transfer of energy between the capacitor C6 and the insect, the latter of which is thereby either killed, stunned, or severely damaged.

An interesting feature of the secondary circuit of transformer T1 is that it contains the plasma discharge tube 17. Were the Cockcroft and Walton multiplying circuit and the capacitor C6 to be perfect components no current would flow in the secondary circuit of transformer T1 once all the capacitors had charged to stable voltages. In practice, however, some current is drawn to make up for losses in the various components and this current is used to energise the plasma discharge lamp 17 which provides ultra-violet light to attract insects to the grid assembly. By choosing a plasma discharge lamp which has an appreciable output in the spectrum visible to the human eye, the lamp 17 can also provide an indication to the user that the apparatus is operating.

WHAT WE CLAIM IS:

1. An insect exterminating apparatus, such apparatus comprising: a hollow grid assembly which can contain an insect lure and comprising at least one first electrode and at least one second electrode; and means for applying a high voltage across the first and second electrodes said means comprising a battery operable DC to DC inverter and a capacitor which is connected across the first and second electrodes and is arranged to store electrical energy supplied by said inverter and which, in use, is dissipated via an insect bridging the first and second electrodes.

2. An apparatus according to claim 1 wherein said inverter comprises a voltage step-up transformer having a secondary winding connected by means of a rectifying circuit across said capacitor.

3. An apparatus according to claim 2 wherein said rectifying circuit comprises a Cockcroft and Walton voltage-multiplying circuit.

4. An apparatus according to claim 2 or 3 and including an oscillator circuit connected to the primary winding of said transformer.

5. An apparatus according to claim 4 and including means for adjusting the operation of said oscillator such that, in use, the oscillator operates when the capacitor is discharged to charge the

capacitor rapidly from the discharged condition to a charged condition and thereafter operates just sufficiently often to compensate for leakages and/or losses so as to maintain the capacitor in the charged condition.

6. An apparatus according to claim 5 wherein the oscillator frequency is adjustable in accordance with a voltage or current applied to an input thereof and said adjusting means is operative to apply to said oscillator input a voltage or current representative of the voltage across the capacitor.

7. An apparatus according to claim 6 wherein said adjusting means is arranged to derive said current or voltage from the back EMF occurring in use across the transformer primary.

8. An apparatus according to claim 7 wherein the adjusting means comprises a diode pump arrangement comprising a further capacitor across which, in use, is produced a voltage representative of the back-EMF on said transformer primary.

9. An apparatus according to claim 8 wherein said diode pump arrangement is connected to said transformer primary *via* a zener diode.

10. Apparatus according to any preceding claim wherein the grid assembly is mounted on a housing, which housing contains said high voltage applying means.

11. An apparatus according to claim 10 and any one of claims 4 to 9 in which the housing is adapted to contain at least one battery for operating said oscillator.

12. Apparatus according to claim 10 or 11 and including a removable guard which is electrically insulated from the grid assembly and is arranged to prevent, when in position on the housing, persons from touching the grid assembly.

13. Apparatus according to claims 11 and 12 and including a switch arranged to interrupt the electrical supply to said oscillator when the guard is removed from the housing and/or the housing is disassembled.

14. Apparatus according to claim 12 or 13, wherein a switch is provided to discharge the said capacitor when the guard is removed from the housing and/or when the housing is disassembled.

15. Apparatus according to claims 12, 13 or 14, wherein the grid assembly is secured to said guard and electrically connected to said capacitor by means of electrical connectors which release when the guard is removed from the housing.

16. Apparatus according to any one of claims 11 to 15 and including a tray for collecting dead insects or insect remains from the grid assembly, the tray being removable from the housing.

17. Apparatus according to any one of claims 12 to 16, wherein the arrangement is such that the guard must be removed from the housing before the tray can be removed.

18. Apparatus according to any preceding claim wherein a receptacle for containing a scent attractant for insects is located within the grid assembly.

19. Apparatus according to claim 18 and claim 16 or 17 wherein the receptacle is formed in the tray.

20. Apparatus according to any one of the preceding claims wherein a lamp for producing ultra-violet light visible exteriorly of the grid assembly to attract insects is located within the grid assembly.

21. Apparatus according to claim 20 and claim 17, 18 or 19, wherein the lamp is mounted within the grid and is energised via electrical connectors which connect the lamp to the high voltage applying means and which release when the guard is removed from the housing.

22. Apparatus according to claim 20 or 21 wherein said lamp is a plasma discharge lamp connected in the secondary winding circuit associated with the or a transformer.

23. Apparatus according to any one of the preceding claims, wherein the first and second electrodes are each substantially helical.

24. Apparatus according to claim 23, wherein the first and second electrodes are arranged to conform to a common portion of a common cylindrical surface, the turns of the first electrode alternating along the length of such cylindrical surface with the turns of the second electrode.

25. Apparatus according to Claim 24, wherein input electrical connections to the first and second electrodes are spaced substantially 120° apart about the axis of the said surface.

26. Apparatus according to claim 24 or 25 wherein the first and second electrodes are connected to electrically insulating supports.

27. An insect exterminating apparatus comprising a hollow grid assembly which can contain an insect lure and comprising a first electrode and a second electrode, the electrodes being wound around a plurality of spaced apart supports such that along the length of each support portions of the first and second electrodes are disposed in alternation, and means for applying a high voltage across the first and second electrodes said means comprising a battery operable DC to DC inverter and a capacitor which is connected across the first and second electrodes and is arranged to store electrical energy supplied by said inverter and which, in use, is dissipated via

an insect bridging the first and second electrodes.

28. Apparatus according to claim 27 wherein the electrodes are substantially helical.

29. Insect exterminating apparatus constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

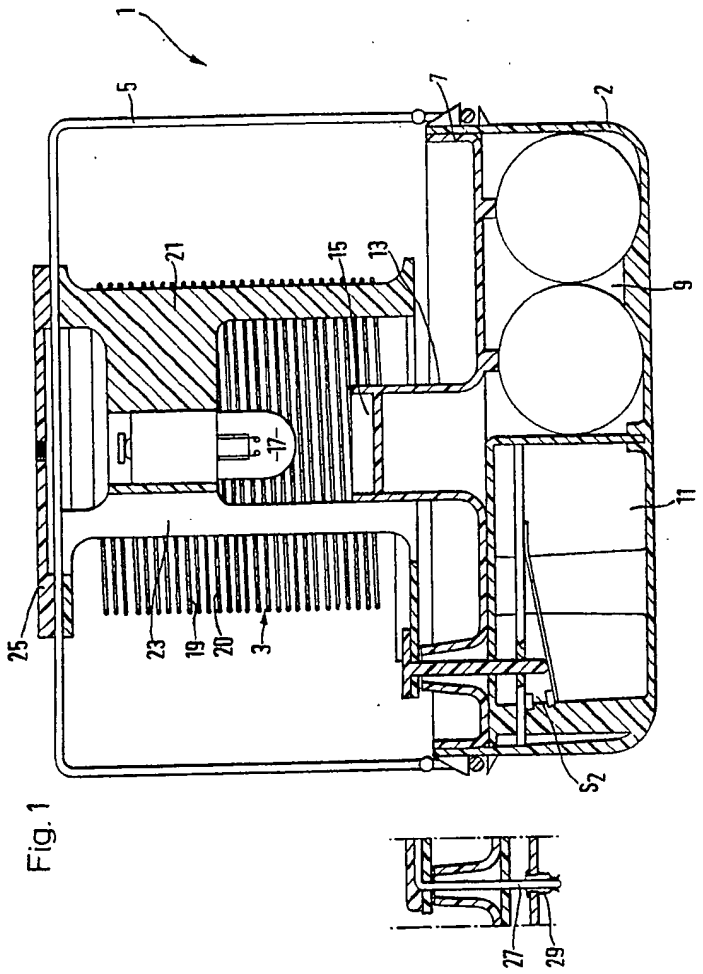

Fig. 1

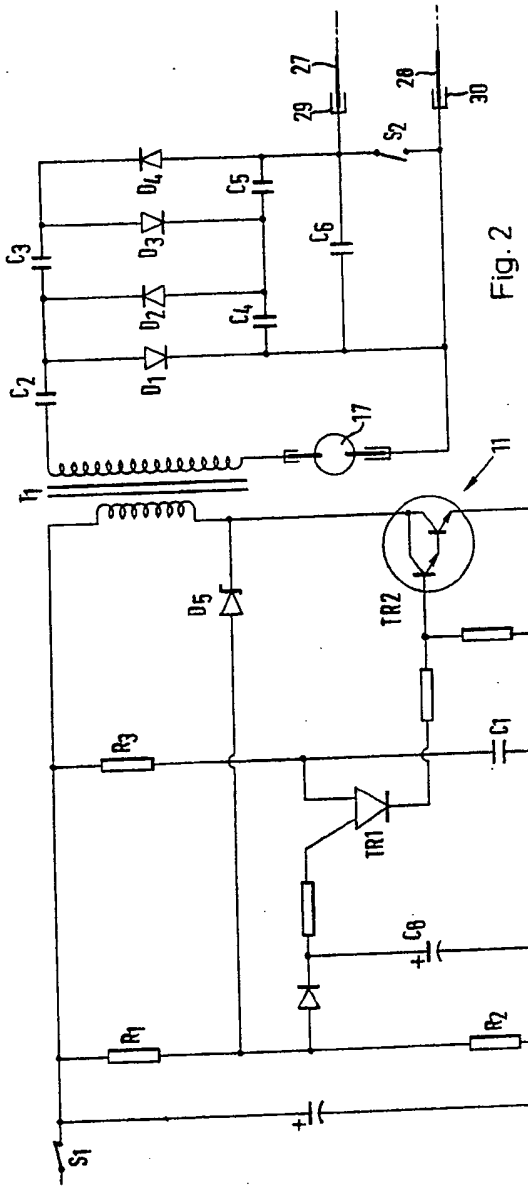

Fig. 2